SECTION 3.0
DESCRIPTION AND COMPARISON OF ALTERNATIVES

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3.0 DESCRIPTION AND COMPARISON OF ALTERNATIVES

This EIS describes and compares the environmental impacts of six alternative container systems for the storage, transport, and possible disposal of naval spent nuclear fuel. A range of alternatives has been considered for naval spent nuclear fuel. Each of these alternatives is described, evaluated, and compared in this chapter on the basis of its potential environmental impacts. In addition, this EIS describes and compares the environmental impacts of the same six alternative container systems for the storage, transport, and possible disposal of low-level waste created from naval spent nuclear fuel management and designated as special case waste, as an action related to the choice of a container system. The incremental increase in risk associated with transport and management of this waste would be less than about 20 percent of the risk from naval spent nuclear fuel alone. For the No-Action Alternative, existing technology would be used.

Until a geologic repository or centralized interim storage site is ready to accept naval spent nuclear fuel, most of it is being stored at the Idaho Chemical Processing Plant. Small library samples are also held at the Expended Core Facility. The current water pool storage facilities at the Idaho Chemical Processing Plant require re-racking for temporary storage, and additional storage facilities may be needed. See the Programmatic SNF and INEL EIS (DOE 1995; Volume 1, Appendix B, Chapter 2.) New water-pool storage facilities will not be constructed. Dry storage is required pursuant to the court-ordered Idaho agreement described in Chapter 1 since water-pool storage does not facilitate the transport of spent nuclear fuel out of the State of Idaho. In accordance with the Idaho agreement, all naval spent nuclear fuel will be removed from water pool storage by the year 2023, 28 years after 1995. Alternative dry storage containers have been selected for evaluation and are described below. The environmental impacts of the alternatives are evaluated in detail in Chapters 4, 5, 6, and 7 for the manufacture of alternative container systems, loading and storage at INEL, unloading at a geologic repository site or centralized interim storage site, and transportation from INEL to a geologic repository site or centralized interim storage site, respectively. The results of these evaluations are summarized in this chapter.

Unlike civilian spent nuclear fuel which is stored in plants throughout the country after removal from the reactor, all pre-examination naval spent nuclear fuel is shipped to one place, INEL, for examination and storage. For this reason, evaluations for the loading and storage of naval spent nuclear fuel at INEL make use of information specific to that location. The Nuclear Waste Policy Amendments Act of 1987 designates Yucca Mountain at the DOE's Nevada Test Site as the only site currently authorized by legislation to be characterized as a geologic repository, and its suitability has not yet been determined. The analysis in this EIS covers transportation from INEL to the Yucca Mountain location as a representative or notional destination. This EIS does not make presumptions concerning the Yucca Mountain site's suitability for a geologic repository or designation for use as a centralized interim storage site. Also, as an analytical convenience for the purposes of this EIS, the notional centralized interim storage site is assumed to be at the same location as a repository.

The shipment of pre-examination naval spent nuclear fuel from shipyards to INEL; the examination, handling, and storage of that spent nuclear fuel at INEL; and the associated effects on human health and the environment which might result have been analyzed and described in detail in the Programmatic SNF and INEL EIS (DOE 1995 Volume 1, Appendix D). This chapter summarizes the results of detailed analyses of the possible environmental impacts from manufacturing suitable containers, loading naval spent nuclear fuel into the appropriate container at INEL under each alternative, storage of naval spent nuclear fuel in the containers at INEL (if the container is suitable for storage), shipment of the naval spent nuclear fuel to a geologic repository or centralized interim storage site, and unloading the containers at a repository or centralized interim storage site.

In addition to a discussion of container systems, the scope of this EIS also includes several actions that are related to the container system choice:

- Manufacturing the container system.
- Handling and transportation impacts associated with the container system.
- Modifications at the Expended Core Facility and the Idaho Chemical Processing Plant at INEL to support loading naval spent nuclear fuel into containers suitable for dry storage. Specifically, expansions at both locations would allow loading operations to take place in either a shielded, filtered-air, dry cell facility, or in an underwater loading facility.
- The location of the dry storage in relation to the Snake River Aquifer. The only alternatives for dry storage that might not be above the aquifer are not currently in the industrial-use areas of INEL.
- The storage, handling and transportation of certain kinds of low-level radioactive waste (characterized as special case waste). Special case waste might reasonably utilize the same container system as is used for naval spent nuclear fuel. For the purposes of this EIS, it is assumed that this action would be implemented.

Several options for container systems have been examined and are described below. The container systems could employ a series of single purpose containers with naval spent nuclear fuel assemblies being individually moved from a site storage container to a transportation container and again to a disposal container. Alternatively, there could be a more integrated system where the assemblies are put into a single container and overpacks are used to meet the special requirements of storage, transportation, and disposal. There are also existing container systems that are various combinations of both. Both the single purpose and the combination systems are typical of current container designs, but there is also interest in fully integrated or multi-purpose container systems.

The principal basis for evaluating the alternatives in this EIS has been radiological and other environmental impacts. These impacts are shown to be small for all alternatives. The evaluation is complicated by the fact that no repository or centralized interim storage site exists to accept the naval spent nuclear fuel from INEL, and the container requirements that might be imposed by these facilities are not known.

The manufacture of alternative container systems would likely be accomplished at one or more of existing manufacturing facilities that are currently producing such containers. Specific vendors would be selected by competitive bidding based on approved specifications. Ideally, the selected container would facilitate handling and disposal operations by minimizing or eliminating the need to remove spent nuclear fuel from containers during storage or transportation. Although naval spent nuclear fuel represents only a very small fraction of the spent nuclear fuel that must be handled at a geologic repository or centralized interim storage site, it is still desirable to ensure that as much as possible of the fuel received at the site can be handled with a single set of facilities and equipment.

The environmental consequences of manufacturing alternative container systems are discussed in Chapter 4 of this EIS and are summarized in this chapter.

For naval spent nuclear fuel, temporary storage could be accomplished at INEL in available space that is conveniently located in the vicinity of the Idaho Chemical Processing Plant and the Naval Reactors Facility, where the Expended Core Facility is located, or at a previously undeveloped location at the INEL not above the Snake River Plain Aquifer, if technically feasible. The siting considerations for a dry storage facility are discussed in Appendix F. Additional information on dry storage is available in the Programmatic SNF and INEL EIS (DOE 1995; Volume 1, Appendix D, Attachment C).

After the necessary containers are procured, naval spent nuclear fuel would be loaded into the containers at INEL for storage and ultimate shipment to a geologic repository or centralized interim storage site. The Yucca Mountain site is used as a representative geologic repository and centralized interim storage site. The possible effects on human health and the environment from handling and storage at INEL and at the repository or centralized interim storage site are presented in Chapters 5 and 6.

Once a geologic repository or centralized interim storage site is available to receive naval spent nuclear fuel, the fuel would be transported to the site by rail in heavily shielded containers. The possible environmental impacts associated with the transportation of naval spent nuclear fuel are described in Chapter 7. The ultimate decision, however, on transportation options will be made by the DOE on the basis of analyses to be performed in the repository EIS. (See also Sections 5.13 and 7.1.) Once at a geologic repository or centralized interim storage site, the containers would be unloaded from the railcars at a surface facility and prepared for ultimate disposition. The extent of this preparation would depend on the container system selected and would involve transferring the naval spent nuclear fuel from shipping containers to disposal containers under all alternatives not using multi-purpose canisters, which can be placed in a disposal container (overpack) without reopening.

Under all alternatives considered, naval spent nuclear fuel would be stored at INEL until 2035 or until the time that a geologic repository or centralized interim storage site is ready to accept it, whichever comes first. Naval spent nuclear fuel is planned to be among the early shipments to a repository or centralized interim storage site. Legislation pending before Congress may require establishment of a centralized interim storage site outside the State of Idaho to which naval spent nuclear fuel could be shipped awaiting placement in a geologic repository. Based on the projected inventory of naval spent nuclear fuel at INEL and current plans for refueling and defueling of naval nuclear-powered vessels, approximately 300 to 500 container shipments of naval spent nuclear fuel would be sent from INEL to a repository or centralized interim storage site between 2010, when a repository (or centralized interim storage site) is planned to begin accepting naval spent nuclear fuel, and 2035, when naval spent nuclear fuel generated up to that time would be completely removed from INEL. Approximately 45 to 85 shipments of special case waste would also be made if the repository or centralized interim storage site were designated to receive it.

If naval spent nuclear fuel could not be accepted by a repository or centralized interim storage site and the spent nuclear fuel shipments commenced later than 2010, more containers may be needed for interim storage of naval spent nuclear fuel at INEL. Between 360 to 585 container shipments would still be required to occur between the time when a repository or centralized interim storage site could begin accepting naval spent nuclear fuel and 2035, when naval spent nuclear fuel generated up to that time would be completely removed from INEL. The actual number of shipments is dependent upon the alternative selected since the capacities of the shipping containers employed in each alternative are somewhat different. Details on shipments of naval spent nuclear fuel are provided in Appendix B. Further information on the need for dry storage is discussed in the Programmatic SNF and INEL EIS (DOE 1995, Volume 1, Appendix B, Chapters 2 and 3).

The following criteria were used to select the alternatives to be assessed for the potential environmental effects of using such containers for storage, transportation, or disposal of naval spent nuclear fuel:

- Designs shall meet the technical requirements found in regulations, specifically 10 CFR Part 72, 10 CFR Part 71, or 10 CFR Part 60 for storage, transportation, or disposal, respectively. If necessary, spent nuclear fuel may be re-loaded at a repository surface facility (or centralized interim storage site) into disposal containers that comply with 10 CFR Part 60.

- Commercial containers that are representative types and licensed by the Nuclear Regulatory Commission shall be assessed.

- Large capacity shall be provided to minimize the need for movement of naval spent nuclear fuel from container to container, container handling, and shipments. One alternative with smaller capacity shall be included to provide flexibility in the choice of a design.

- A No-Action Alternative shall be included using containers that are currently available.

- An appropriate variation of currently-available containers shall be included to assess the effects of such variations.

- The alternatives shall be economical and consistent with technical requirements.

Consideration of these criteria, the currently available containers, the representative commercial containers, and existing technology led to the following list of alternatives selected for environmental analysis:

1. Multi-Purpose Canister —- a metal canister, sealed by welding, and used with separate, specialized overpacks for storage, transportation, and disposal in a geologic repository of spent nuclear fuel. Overpacks provide the necessary confinement, radiation shielding, impact resistance, and environmental protection for a canister to meet the regulatory requirements cited above in the criteria for selecting alternatives.

2. No-Action Alternative — currently available shielded transportation casks (M-140 or M-130) that are approved by the Nuclear Regulatory Commission are used to transport naval spent nuclear fuel from naval sites to INEL. Commercially available dry storage containers would be procured and used for dry storage. The existing M-140 and M-130 casks are sealed with a gasketed and bolted lid and could be approved for dry storage. Additional M-140s would be procured and used to transport

naval spent nuclear fuel from INEL to a geologic repository or centralized interim storage site.

3. Current Technology/Rail — this is equivalent to the No-Action Alternative except that this alternative uses new internal structures in the M-140 to increase the capacity for spent nuclear fuel and reduce the required number of shipments.

4. Transportable Storage Cask — a commercially available cask that is licensed by the Nuclear Regulatory Commission for both storage and transport of spent nuclear fuel.

5. Dual-Purpose Canister — a commercially available canister that is licensed by the Nuclear Regulatory Commission for both storage and transport of spent nuclear fuel. Specialized overpacks would be procured for storage and transport.

6. Small Multi-Purpose Canister — a canister system, but smaller in capacity than the first alternative, to provide flexibility in a choice of design.

The estimated quantities of required equipment for each alternative are provided in Table 3.1. The table entries show the separate requirements for naval spent nuclear fuel shipments and for special case waste shipments. For example, for the Multi-Purpose Canister Alternative 300 canisters would be required for naval spent nuclear fuel shipments and 60 canisters would be required for special case waste shipments. In addition, 150 storage overpacks, 15 transportation overpacks, and 300 disposal overpacks would be required for the total number of naval spent nuclear fuel shipments. The corresponding values for the total number of special case waste shipments are also shown in Table 3.1. The characteristics of the required equipment are described in Chapter 4.

TABLE 3.1 Summary of Estimated Required Equipment for Shipments Starting in 2010[a]

Alternative	Canisters	Storage Overpacks or Containers[b]	Transportation Overpacks or Casks	Disposal Containers	Disposal Overpacks
	SNF/SCW	SNF/SCW	SNF/SCW	SNF/SCW	SNF/SCW
MPC	300 / 60	150(so) / 30(so)	15(to) / 3(to)	0 / 0	300 / 60
No-Action	0 / 0	225(sc) / 30(sc)	24(tc) / 4(tc)	300 / 60	0 / 0
Current Technology/Rail	0 / 0	150(sc) / 26(sc)	Fewer than 24(tc) / 4(tc)	300 / 60	0 / 0
Transportable Storage Cask	0 / 0	150(sc) / 21(sc)	0 / 0	300 / 60	0 / 0
Dual-Purpose Canister	300 / 45	150(so) / 23(so)	15(to) / 3(to)	300 / 60	0 / 0
Small MPC	500 / 85	225(so) / 39(so)	25(to) / 5(to)	0 / 0	500 / 85

[a] Notation: SNF = Naval Spent Nuclear Fuel; SCW = special case waste; MPC = Multi-Purpose Canister; (so) = storage overpack; (sc) = storage container; (to) = transportation overpack; (tc) = transportation cask.
[b] Storage Containers = Single-purpose storage canisters or storage casks.

Further details on the selected alternatives are provided in the following sections.

3.1 Multi-Purpose Canister Alternative

Under the Multi-Purpose Canister Alternative, naval spent nuclear fuel would be placed in a large (125-ton), multi-purpose canister. Several types of internal canister baskets would be used because of differences in fuel dimensions in naval spent nuclear fuel types. These different baskets do not affect the environmental impacts of the canisters. This difference applies to all of the alternatives.

The manufacturing processes for the multi-purpose canisters are similar to those currently used for large storage and transportation containers. The processes are discussed in Section 4.1.1.1 of Chapter 4, including fabrication of the canister overpacks that would be required for storage, transportation, and disposal. Licensed container systems similar to the TRW conceptual design, cited in Section 4.1.1 and used for analysis purposes for this alternative, may become available in the future and might be selected.

Under this alternative, approximately 300 multi-purpose canisters would be needed for naval spent nuclear fuel, and 60 more for special case waste. The number of containers has been overestimated so that the corresponding analyses will produce conservative results.

The multi-purpose canisters would be loaded at the facilities for handling naval spent nuclear fuel at INEL: the Idaho Chemical Processing Plant or the Expended Core Facility. Following loading into multi-purpose canisters, the naval spent nuclear fuel could be stored at INEL in multi-purpose canisters, inside a suitable shielded overpack, until a repository or centralized interim storage site is ready to receive it. Prior to shipment of the naval spent nuclear fuel, the multi-purpose canisters would be transferred from the storage overpacks to suitable transportation overpacks and loaded onto railcars for the trip to a repository or centralized interim storage site. The storage overpacks and transportation overpacks used for naval spent nuclear fuel would be re-used as appropriate. At the end of the entire program, about 180 storage overpacks and 18 transportation casks would need to be reused or recycled. Scrap metals would be recycled and concrete material would result in non-radiological solid waste. Recycling and management of end-of-life equipment for each alternative is discussed in Section 4.5.2 of Chapter 4.

The containers loaded with naval spent nuclear fuel or special case waste would be shipped by rail, using commercial rail lines as part of commonly scheduled trains traveling to the vicinity of a geologic repository or centralized interim storage site. This is an extension of the proven safe, historical practices used to transport naval spent nuclear fuel from shipyards to INEL since 1957. Dedicated trains may be used when appropriate. Approximately 360 container shipments using a multi-purpose canister system would be required; the actual number of trains required would be lower than the number of container shipments since each train would likely contain several multi-purpose canisters. Once at the surface facility of a geologic repository or centralized interim storage site, the containers would be unloaded from the railcars, naval spent nuclear fuel and special case waste would be unloaded from transportation casks and placed into disposal overpacks, and other preparations for disposal or interim storage would be performed. This EIS evaluates in Chapter 6 the impacts of unloading naval spent nuclear fuel and special case waste from the railcars to determine if there would be any differences among container systems associated with unloading actions. Activities concerning the disposal of naval spent nuclear fuel or special case waste beyond this point in the process would be evaluated in an appropriate EIS.

3.2 No-Action Alternative

The No-Action Alternative is based on using existing technology to handle, store, and subsequently transport naval spent nuclear fuel or special case waste to a geologic repository or centralized interim storage site. Currently, either the M-140 or the smaller M-130 transportation casks, which are approved in accordance with Nuclear Regulatory Commission and U.S. Department of Transportation requirements, are used to transport pre-examination naval spent nuclear fuel from naval sites to INEL. The M-140 transportation cask is designed for dry shipment and dry storage and uses passive cooling. (The M-130 cask is similar in design and ruggedness to the M-140, and either cask could be approved for dry storage.) The Naval Nuclear Propulsion Program has used these and similar shipping containers to transport spent nuclear fuel from naval shipyards to INEL since 1957 without adverse environmental impact. Naval spent nuclear fuel and special case waste have been stored safely at INEL in water pools over the same period. Storage in dry storage systems, such as those currently available from several companies, will be used in the future, as analyzed in the recent Programmatic SNF and INEL EIS concerning management of spent nuclear fuel under DOE cognizance (DOE 1995). Additional storage capacity will be needed in the future. Commercially available dry storage containers would be procured and used for dry storage.

All of the Navy's currently available M-140 transportation casks will be required to transport pre-examination naval spent nuclear fuel from scheduled refuelings and defuelings of naval nuclear reactors to INEL for examination over the next 40 years, so additional M-140 transportation casks would have to be manufactured to accommodate the shipment of naval spent nuclear fuel and special case waste from INEL to a geologic repository or centralized interim storage site. The M-130 casks are not planned to be used to transport naval spent nuclear fuel from INEL to a geologic repository or centralized interim storage site; therefore additional M-130 casks would not be required. These transportation casks would make use of the same or similar internal equipment for supporting the naval spent nuclear fuel assemblies as is used for shipment to INEL. Approximately 28 additional M-140 transportation casks would be needed to handle the number of shipments required each year to move all the naval spent nuclear fuel and the special case waste generated through 2035 to a repository or centralized interim storage site. The additional transportation casks would be manufactured by one or more commercial heavy equipment manufacturers who would be chosen using a competitive bidding process. The manufacturing processes for the M-140 casks are discussed in Section 4.1.1.2.

Prior to shipment to a geologic repository or centralized interim storage site, naval spent nuclear fuel and special case waste would be stored at INEL primarily in commercially available dry storage containers. The naval spent nuclear fuel or special case waste would be loaded from storage into M-140 transportation casks for shipment from INEL to a geologic repository or centralized interim storage site as soon as a repository or centralized interim storage site is ready to receive it. The containers of naval spent nuclear fuel or special case waste would be shipped by rail, using commercial rail lines as part of commonly scheduled trains traveling to the vicinity of a repository or centralized interim storage site. Dedicated trains may be used when appropriate. No rail link to the Yucca Mountain site currently exists, and if Yucca Mountain were to become the site of a repository or centralized interim storage facility, heavy-haul transport might be used instead of a rail connection, as discussed in Appendix B, Section B.4. All of the alternative container systems would be suitable for heavy-haul transportation, as illustrated by prior use of the M-140 containers in heavy-haul transport. However, it is accurate to state that the M-140 based alternatives would be less suitable due to size, height, and weight. Approximately 425 container shipments would be required to complete the transfer of naval spent nuclear fuel by the end of the year 2035.

The naval spent nuclear fuel or special case waste would be unloaded from the M-140 transportation casks and placed in the surface facilities of a geologic repository for loading into disposal containers. Of all the alternatives, the two that use the M-140 transportation casks have the potential to significantly impact the final design of the repository surface facilities or centralized interim storage site facilities due to the size and weight of the casks. It is expected that the special requirements that the M-140 casks present can be accommodated such that operations anticipated for unloading naval spent nuclear fuel from M-140 transportation casks do not present any increased risks when compared to the operations required to unload the other container alternatives. Naval spent nuclear fuel and special case waste would not normally be stored at the surface facility of a repository site, but would be prepared for disposal directly after unloading from the M-140 transportation casks. The fuel or waste may be placed in temporary storage at a repository for a short period for operational purposes. Following unloading, the shipping casks would be returned to INEL for use in other shipments of naval spent nuclear fuel and special case waste. At the end of the entire program, about 255 storage overpacks, 255 storage containers and 28 casks would need to be reused or recycled. Scrap metals would be recycled, concrete would be disposed of as non-radiological solid waste. The casks and storage containers would need to be radiologically decontaminated prior to recycling or they would need to be managed as low-level radioactive waste. (Section 4.5.2)

3.3 Current Technology/Rail Alternative (Current Technology Supplemented by High-Capacity Rail Casks)

This alternative differs from the No-Action Alternative only in the use of different internal baskets in the same M-140 casks. These redesigned internal baskets support the naval spent nuclear fuel and would accommodate a larger amount of naval spent nuclear fuel and special case waste than the current design. The M-140 would be used for this alternative since its design can accommodate all naval spent nuclear fuel assembly configurations. The manufacturing processes for the high-capacity M-140 casks are discussed in Section 4.1.1.2. The primary difference between this alternative and the No-Action Alternative would be in the smaller total number of shipments to a geologic repository or centralized interim storage site, totaling about 325 container shipments of naval spent nuclear fuel through 2035. At the end of the entire program, about 176 storage overpacks, 176 storage containers, and 28 casks would need to be reused or recycled as discussed in Section 3.2 above for the No-Action Alternative.

3.4 Transportable Storage Cask Alternative

Under this alternative, an existing cask that is available from a commercial manufacturer and designed to Nuclear Regulatory Commission standards for storage and shipment of civilian spent nuclear fuel would be used to transport naval spent nuclear fuel and special case waste to a geologic repository or centralized interim storage site. A cask is a heavily shielded container and uses a gasketed and bolted closure; unlike a canister, no overpack is required. The cask could also be used for dry storage of naval spent nuclear fuel and special case waste at INEL. Transportable storage casks are suitable for storage and shipment without additional shielding. The NAC-STC container, recently licensed by Nuclear Assurance Corporation for both uses, is an example of such a cask that is commercially available at the present time. The design of the NAC-STC cask has been used in this EIS to represent this type of container, though this does not mean that it is the design which would be chosen. Similar, licensed transportable storage casks are likely to become available in the future and any one of the available designs might be selected.

The transportable storage cask could also be used for storage at INEL. Transportable storage casks would be procured and used when storage capacity in other INEL facilities becomes exhausted or as the opportunity arises to transport naval spent nuclear fuel or special case waste to a geologic repository or centralized interim storage site. The manufacturing processes for the transportable storage casks are discussed in Section 4.1.1.2 of Chapter 4.

Naval spent nuclear fuel or special case waste would be loaded into the casks at the existing facilities for handling naval spent nuclear fuel and special case waste at INEL. The fuel or waste would be loaded from its current storage location into the transportable storage casks and would be stored at INEL until the time that a geologic repository or centralized interim storage site is ready to receive it.

Naval spent nuclear fuel and special case waste would be shipped in the transportable storage casks from INEL to a geologic repository or centralized interim storage site by rail, using commercial rail lines as part of commonly scheduled trains traveling to the vicinity of a repository or centralized interim storage site. Dedicated trains may be used when appropriate. At a repository, the naval spent nuclear fuel or special case waste would be unloaded from the transportable storage casks and loaded into disposal containers. Approximately 325 transportable storage cask container shipments of naval spent nuclear fuel would be needed through 2035. The unloaded transportable storage casks would be returned to INEL, as necessary, for further storage and transport. At the end of the entire program, about 171 casks would need to be reused or recycled. (Section 4.5.2)

3.5 Dual-Purpose Canister Alternative

This alternative would make use of a licensed canister system such as the NUHOMS-MP187® system offered by VECTRA, with suitable internal baskets designed to accommodate naval spent nuclear fuel and special case waste for both storage and shipment to a geologic repository or centralized interim storage site. This alternative differs from the transportable storage cask described in Section 3.4 primarily in the nature of the container system used. In this case, the spent nuclear fuel would be placed and sealed in a single canister which would be inserted, in turn, into different overpacks for storage or for shipment. As in the case of the transportable storage casks, a commercial design (the NUHOMS-MP187®) has been used in the analyses in this EIS to represent this type of container, but that does not mean that it is the design which would be chosen. Similar, licensed dual-purpose canister systems may become available in the future and any one of the available designs might be selected. The manufacturing processes for the dual-purpose canister are essentially the same as those for the multi-purpose canister. The processes are discussed in Section 4.1.1.1, including the associated overpacks that would be required.

As in the Transportable Storage Cask Alternative, naval spent nuclear fuel or special case waste would be loaded into the dual-purpose canisters at the Idaho Chemical Processing Plant or the Expended Core Facility. If the naval spent nuclear fuel or special case waste were to be stored prior to shipment, each canister would be placed into an overpack or facility designed to provide shielding and other characteristics needed for safe storage. When a geologic repository or centralized interim storage site is ready to accept the spent nuclear fuel or special case waste, the canisters would be removed from the storage system and be placed into overpacks which would satisfy shielding, structural strength, and other requirements for shipment. The Dual-Purpose Canister Alternative would require about 300 container shipments of naval spent nuclear fuel from INEL through 2035. At a repository, the individual naval spent nuclear fuel assemblies or special case waste would be transferred to disposal containers at the surface facilities to be prepared for placement in a repository. The transportation overpacks would be returned to INEL for reuse. At the end of the entire program, about 345 canisters, 173 storage overpacks, and 18 transportation overpacks would need to be reused or recycled. (Section 4.5.2)

3.6 Small Multi-Purpose Canister Alternative

Under this alternative, naval spent nuclear fuel or special case waste would be placed in a smaller, 75-ton multi-purpose canister rather than a larger, 125-ton canister. The 75-ton alternative was identified as an alternative to the 125-ton canister as a result of public concern, expressed in a scoping meeting, for potential damage to railway trackage from the weight of the 125-ton canister system. Either size could be used for naval spent nuclear fuel or special case waste. Both sizes are described and evaluated as separate alternatives to provide flexibility in the choice of a design.

The small multi-purpose canister system would function in a manner identical to that described in Section 3.1 for storage, transport, and disposal. Approximately 500 small multi-purpose canisters would be needed for naval spent nuclear fuel shipments under this alternative. Approximately 200 more small multi-purpose canisters would be required than if the larger, Multi-Purpose Canister counterpart were selected. However, the number of containers required for naval spent nuclear fuel and special case waste would still represent a small percentage of the total number of containers that would need to be handled at a geologic repository or centralized interim storage site. The manufacturing processes for the small multi-purpose canisters and overpacks are essentially the same as those for the larger multi-purpose canister. They are discussed in Section 4.1.1.1. At the end of the entire program, about 264 storage overpacks and 30 transportation overpacks would need to be reused or recycled as discussed for the Multi-Purpose Canister Alternative. (Section 4.5.2)

3.7 Alternatives Eliminated from Detailed Analysis

Most types of spent nuclear fuel container systems either in use or proposed for use have been included as alternatives to be analyzed in this EIS. This section describes alternatives that were considered and subsequently eliminated from detailed analysis.

The universal cask, or multi-purpose unit, is a concept for a single cask that would satisfy all the requirements for storage, transportation, and disposal of naval spent nuclear fuel and special case waste. The multi-purpose unit would function as the multi-purpose canister system does, but the various overpacks would be integral parts of the universal cask. As with the multi-purpose canister, the individual spent fuel assemblies would not be handled again after sealing. Because the two systems are functionally similar, and because no feasible universal cask design currently exists that would be capable of receiving Nuclear Regulatory Commission certification, the universal cask was not considered further.

License applications for other systems of the types already described might be submitted in the future by vendors. Any potential impacts of using such proposed canisters or casks are expected to be bounded by the alternatives evaluated in this EIS. Therefore, other potential designs were not analyzed further.

All of the alternatives addressed in this EIS utilize dry storage of naval spent nuclear fuel at INEL. Storage of naval spent nuclear fuel in water pools compared with dry storage has been described in detail in the Programmatic SNF and INEL EIS (DOE 1995 Volume 1, Appendix D, Attachment C). That EIS concluded that naval spent nuclear fuel could be stored either way without significant impact on human health or the environment, and presented Nuclear Regulatory Commission conclusions on these two storage methods. The Nuclear Regulatory Commission concluded that for dry storage, all areas of safety and environmental concern (such as maintenance of systems and components, prevention of material degradation, and protection against accidents and sabotage) have been addressed and shown to present no more potential for adverse impact on the environment and public health and safety than storage of spent nuclear fuel in water pools. The Nuclear Regulatory Commission also concluded that dry container storage involves a simpler technology than that represented by water storage systems (NRC 1984). In addition, the use of water pools was eliminated from detailed analysis because the agreement between the State of Idaho and the Federal government involving the shipment of additional spent nuclear fuel to the INEL includes a provision that all spent nuclear fuel at INEL will be transferred from wet storage to dry storage (U.S. District Court, 1995).

Analyses in this EIS are based on the use of rail transportation for naval spent nuclear fuel because it is current practice for pre-examination naval spent nuclear fuel. Since 1957, over 660 container shipments of pre-examination naval spent nuclear fuel have been made safely to INEL by rail from shipyards and prototypes. It is a reasonable extension of proven technology to evaluate alternative container systems for rail shipments of post-examination naval spent nuclear fuel from

INEL to a notional or representative repository. With this experience base of safe transportation by rail, it is not the purpose of this EIS to change to another mode of transportation for naval spent nuclear fuel, such as to transportation by legal-weight truck. The proposed action of this EIS does not entail actual shipment to a geologic repository or to a centralized interim storage site. Including the impacts of transporting the container system to, and unloading at a representative or notional interim storage facility or repository, ensures that the container system selected is compatible with these operations at the facilities to the extent they are understood at this time.

The use of trucks as the principal means for transporting naval spent nuclear fuel was also eliminated from detailed analysis in this EIS for other reasons. Rail transport permits the shipment of a greater number of spent fuel assemblies in each shipment than truck transport, resulting in fewer shipments. Those container systems which can be physically accommodated by truck would require many more shipments, with resultant increased environmental impacts. Preliminary estimates show that at least five times the number of shipments would be required for transport by truck as compared to rail. Since each container must be designed to the same regulatory requirements (10 CFR 71), each container would be expected to produce about the same radiological dose rate on the exterior surface of the container. However, considering the population distribution and proximity of people along and on the truck route, each truck shipment results in about five times greater radiation exposure than a rail shipment. Thus the five times greater number of shipments required for truck rather than rail transportation would be expected to result in about twenty-five times greater radiological dose to the public and workers. Transportation accident rates in general commerce are higher per truck mile than per rail mile (Saricks and Kvitek, 1994). While the accident rate is not large for either rail or truck, the number of accidents could be about five times larger for truck shipments than for rail due to the greater number of shipments.

In addition, the location of an interim storage facility or a repository is not known at this time. Since the location is not known, there are no details concerning the method of access into the site. A possible location (Yucca Mountain) has been included in this EIS only for transportation analysis purposes, since it is the only location identified for characterization in the Nuclear Waste Policy Act.

In view of the above, the Naval Nuclear Propulsion Program has eliminated from consideration a shift to legal-weight truck transportation as a reasonable alternative to be evaluated in detail in this EIS for naval spent nuclear fuel. The ultimate decision on transportation options (legal-weight truck, some combination of legal-weight truck and rail or rail/heavy-haul truck) will be made by the Department of Energy on the basis of analyses to be performed in the repository EIS.

3.8 Comparison of Alternatives

This section provides comparisons among the alternatives as they relate to the activities associated with naval spent nuclear fuel and special case waste. The comparisons focus on those topics that are projected to have the more important environmental impacts during manufacturing, during loading, storage, and unloading at facilities, or along transportation routes, as discussed in Chapters 4, 5, 6, and 7. The impacts for most impact categories are small or nonexistent. The topics not discussed in detail because of small or nonexistent impacts include noise and visual resources, water resources, ecological resources, cultural resources, soils and geology, and utilities and energy.

The principal differences among the alternatives occur in the categories of occupational and public health and safety (including normal operations and accidents for facility operations and transportation operations) and total radiological impacts. Even in these categories, the overall impacts and the differences among the alternatives are small and indicate that only negligible unavoidable adverse effects are anticipated.

Some of the activities described in this EIS would result in radiation exposures to the workers and the public from facility operations and transportation activities. Additional radiation exposures could occur as a result of transportation or facility accidents. Any radiation exposures from these activities would be in addition to exposures that normally occur from natural sources such as cosmic radiation (involuntary exposure) and from artificial sources such as chest x-rays (voluntary exposure).

Summaries of radiological impacts resulting from normal operations and from hypothetical accidents are provided in Tables 3.2 and 3.3, respectively.

Table 3.2 provides an overall comparison of the alternatives during normal operations. This comparison is presented in terms of the increase in the latent cancer fatalities that could occur in the general population due to loading, dry storage, unloading, or transportation to a geologic repository or centralized interim storage site during the 40-year period after an alternative has been implemented. This increase in latent cancer fatalities is subdivided to show how much is associated with normal operations at the facilities and with incident-free transportation operations involving naval spent nuclear fuel and special case waste.

For example, it is calculated that for the Multi-Purpose Canister Alternative in which naval spent nuclear fuel might be stored, shipped, and disposed of, there would be:

- An increase of between about 2.2 one millionths (2.2×10^{-6}) to 2.0 one hundred thousandths (2.0×10^{-5}) of a latent cancer fatality in the 40-year period for the general population around the Naval Reactors Facility or Idaho Chemical Processing Plant due to loading and storage of naval spent nuclear fuel before shipment to a geologic repository or centralized interim storage site. That is, over the next 40 years, less than one additional latent cancer fatality would be expected among the 120,000 people who live within 50 miles (approximately 80 km) of the facility, or about one latent cancer fatality if the entire handling and storage program for this fuel were repeated more than 50,000 times.

- No increase in latent cancer fatalities in the 25-year period for the general public around a geologic repository or centralized interim storage site if either the large or the small multi-purpose canister were selected, because the multi-purpose canister would be sealed and would not contribute any airborne releases. Any of the other alternatives would increase the latent cancer fatalities in the general public by about 0.00030 during the 25-year period.

- An increase of about 0.0075 latent cancer fatalities in the 25-year period for the general population along the transportation routes due to incident-free transportation of naval spent nuclear fuel to a geologic repository or centralized interim storage site. That is, during those 25 years, less than one latent cancer fatality would result, or about one fatality if the entire transport program for this fuel were to be repeated about 130 times.

TABLE 3.2 Summary of Collective Doses and Latent Cancer Fatalities (and Risk) in the General Population Due to the Normal Operations of Loading, Dry Storage, Unloading, and Incident-Free Transportation of Naval Spent Nuclear Fuel and Special Case Waste, 1996-2035[a,b]

Alternative	NRF		ICPP		Repository/Centralized Interim Storage Facility		Transportation[c]	
	Collective Dose Person-Rem	Latent Cancer Fatalities	Collective Dose Person-Rem	Latent Cancer Fatalities	Collective Dose Person-Rem	Latent Cancer Fatalities	Collective Dose Person-Rem	Latent Cancer Fatalities
MPC	0.0044	2.2×10^{-6}	0.039	2.0×10^{-5}	0[d]	0[d]	15	7.5×10^{-3}
NAA	0.37	1.9×10^{-4}	0.31	1.5×10^{-4}	0.60	3.0×10^{-4}	2.0	1.0×10^{-3} [e]
CTR	0.37	1.9×10^{-4}	0.31	1.5×10^{-4}	0.60	3.0×10^{-4}	1.6	8.0×10^{-4} [e]
TSC	0.0044	2.2×10^{-6}	0.039	2.0×10^{-5}	0.60	3.0×10^{-4}	14	7.2×10^{-3}
DPC	0.0044	2.2×10^{-6}	0.039	2.0×10^{-5}	0.60	3.0×10^{-4}	15	7.4×10^{-3}
SmMPC	0.0044	2.2×10^{-6}	0.039	2.0×10^{-5}	0[d]	0[d]	24	1.2×10^{-2}

[a] Notation: SNF = naval spent nuclear fuel; SCW = special case waste; MPC = Multi-Purpose Canister; NAA = No-Action Alternative; CTR = Current Technology/Rail; TSC = Transportable Storage Cask; DPC = Dual-Purpose Canister; SmMPC = Small Multi-Purpose Canister, NRF = Naval Reactors Facility (including the Expended Core Facility), and ICPP = Idaho Chemical Processing Plant. Both NRF and ICPP are at INEL.

[b] Values from Tables A.10, A.11, A.12, and B.10. This table assumes 40 years of exposure to loading and dry storage operations for NRF (28 years for ICPP loading) and 25 years of exposure to transportation and repository operations.

[c] Transportation values from Table B.10 are for 25 years of shipments.

[d] Sealed MPCs would not contribute any airborne releases; they would not have to be re-opened.

[e] Actual historic measured dose rates have been used for the M-140 casks.

The results in Table 3.2 indicate that the collective doses and latent cancer fatalities for 40 years of normal operations at the Naval Reactors Facility and at the Idaho Chemical Processing Plant are noticeably higher for the No-Action Alternative and the Current Technology/Rail Alternative. This is due mainly to the assumed release of carbon-14 from opening of containers in dry storage to place fuel assemblies into the M-140 transportation cask at the Naval Reactors Facility and the Idaho Chemical Processing Plant, but the corresponding risks of latent cancer fatalities are less than 0.0002. Additional details are provided in Section A.2.4. At a repository or centralized interim storage facility, the collective doses and the latent cancer fatalities are expected to be zero for both the Multi-Purpose Canister Alternative and the Small Multi-Purpose Canister Alternative because these canisters are sealed, would not have to be re-opened, and would not contribute any airborne release of radioactive material. The collective doses and latent cancer fatalities associated with incident-free transportation are noticeably lower for both the No-Action Alternative and the Current

Technology/Rail Alternative because the calculations are based on actual historic measured dose rates for the M-140 casks. This indicates that the transportation impacts for the other alternatives have been calculated conservatively and as a group are about the same.

It is important to emphasize that these latent cancer fatalities are calculated results rather than actual expected fatalities. This is because the expected number of such fatalities during normal operations is so small as to be unmeasurable and indistinguishable relative to the larger number of such deaths expected from naturally occurring conditions and other man-made effects not related to naval spent nuclear fuel operations. This is not meant to trivialize the importance of radiation-induced cancer fatalities but, rather, to put the issue in perspective.

How should one interpret a noninteger number of latent cancer fatalities, such as 0.05? The answer is to interpret the result as a statistical estimate. That is, 0.05 is the average number of deaths that would be expected if the same exposure situation were applied to many different groups of 100,000 people. In most groups, nobody (0 people) would incur a latent cancer fatality from the 0.001 rem (1 millirem) dose each member would have received. In a small fraction of the groups, 1 latent fatal cancer would result; in exceptionally few groups, 2 or more latent fatal cancers would occur. The average number of deaths over all the groups would be 0.05 latent fatal cancers (just as the average of 0, 0, 0, and 1 is 1/4, or 0.25). The most likely outcome is 0 latent cancer fatalities.

These same concepts apply to estimating the effects of radiation exposure on a single individual. Consider the effects, for example, of exposure to background radiation over a lifetime. The "number of latent cancer fatalities" corresponding to a single individual's exposure over a (presumed) 72-year lifetime to 0.3 rem (300 millirem) per year is the following:

1 person x 0.3 rem (300 millirem)/year x 72 years x 0.0005 latent cancer fatalities/person-rem = 0.011 latent cancer fatalities.

Again, this should be interpreted in a statistical sense; that is, the estimated effect of background radiation exposure on the exposed individual would produce a 1.1 percent chance that the individual might incur a latent fatal cancer caused by the exposure. Said another way, about 1.1 percent of the population is estimated to die of cancers induced by the radiation background.

The dose-to-risk conversion factors presented above and used in this EIS to relate radiation exposures to latent cancer fatalities are based on the "1990 Recommendations of the International Commission on Radiation Protection" (ICRP 1991). These conversion factors are consistent with those used by the U.S. Nuclear Regulatory Commission in its rulemaking "Standards for Protection Against Radiation" (U.S. Nuclear Regulatory Commission, 1991). In developing these conversion factors, the International Commission on Radiological Protection reviewed many studies, including Health Effects of Exposure to Low Levels of Ionizing Radiation, BEIR V (National Academy of Sciences/National Research Council 1990) and Sources, Effects and Risks of Ionizing Radiation (United Nations 1988). These conversion factors represent the best-available estimates for relating a dose to its effect; most other conversion factors fall within the range of uncertainty associated with the conversion factors that are discussed in the National Academy of Sciences/National Research Council publication (1990). The conversion factors apply where the dose to an individual is less than 20 rem (20,000 millirem) and the dose rate is less than 10 rem (10,000 millirem) per hour. At doses greater than 20 rem (20,000 millirem), the conversion factors used to relate radiation doses to latent cancer fatalities are doubled. At much higher doses, prompt effects, rather than latent cancer fatalities, may be the primary concern. Unusual accident situations that may result in high radiation doses to individuals are considered special cases.

Table 3.3 presents the estimates of the average annual risk of latent cancer fatalities in the general population from hypothetical accidents involving naval spent nuclear fuel at the facilities or during transportation. The values are subdivided to show how many are estimated to occur at the Naval Reactors Facility, the Idaho Chemical Processing Plant, at a geologic repository or centralized interim storage facility, or along the transportation route to a repository or centralized interim storage site. The risks with special case waste alone would be smaller by a factor of about five.

TABLE 3.3 Average Annual Risk of Latent Cancer Fatalities in the General Population from Hypothetical Accidents Involving Naval Spent Nuclear Fuel at Facilities or during Transportation[a]

Alternative	NRF	ICPP	Repository/Centralized Interim Storage Facility	Transportation[b,c]
Multi-Purpose Canister	1.7×10^{-7}	2.4×10^{-6}	1.5×10^{-8}	1.1×10^{-7}
No-Action	1.7×10^{-7}	2.4×10^{-6}	1.0×10^{-8}	8.8×10^{-8}
Current Technology/Rail	1.7×10^{-7}	2.4×10^{-6}	1.8×10^{-8}	8.4×10^{-8}
Transportable Storage Cask	1.7×10^{-7}	2.4×10^{-6}	1.8×10^{-8}	1.4×10^{-7}
Dual-Purpose Canister	1.7×10^{-7}	2.4×10^{-6}	1.8×10^{-8}	1.2×10^{-7}
Small Multi-Purpose Canister	1.7×10^{-7}	2.4×10^{-6}	1.0×10^{-8}	1.0×10^{-7}

[a] Values from Tables A.3 and B.12. Notation: NRF = Naval Reactors Facility; ICPP = Idaho Chemical Processing Plant.
[b] The larger value for either submarine or surface ship fuel assemblies was used.
[c] Values from Table B.12 divided by 25 years to estimate the average annual risk.

For example, it is calculated that for the Multi-Purpose Canister Alternative in which naval spent nuclear fuel might be stored, shipped, and disposed of, there would be:

- An increase of about 2.4 one millionths (2.4×10^{-6}) in the usual risk of a latent cancer fatality per year for the general population due to the facility accident with the highest risk. That is, about one in 400,000 years of continuous operations. In this case, the accident presenting the highest risk would be associated with the handling and storage of naval spent nuclear fuel at the Idaho Chemical Processing Plant location at INEL.

- An increase of about 1.5 one hundred millionths (1.5×10^{-8}) per year in the usual risk of a latent cancer fatality for the general population due to hypothetical accidents at the repository surface facilities. That is, one additional fatality in about 60 million years.

- An increase of about 1.1 ten millionths (1.1×10^{-7}) in the usual risk of a latent cancer fatality per year for the general population due to hypothetical transportation accidents en route from INEL to a geologic repository or centralized interim storage site. That is, one additional fatality in about 9 million years of continuous operations.

Table 3.3 above shows the risks of latent cancer fatalities due to the potential accidents associated with handling, storage, and transportation of naval spent nuclear fuel for any of the alternatives. In all of these cases, many additional years of repetition of the actions considered would be required before a single additional latent cancer fatality would be expected to occur. The results also indicate that the risks of latent cancer fatalities from the hypothetical accidents at these facilities and during transportation are about the same for all of the alternatives evaluated; among the alternatives in each category, the ranges of results are all within a factor of two.

Hypothetical accidents are evaluated to estimate the highest number of latent cancer fatalities. In the unlikely event of a serious accident involving a plane crash into a dry storage area for naval spent nuclear fuel, it is estimated that about 600 acres (approximately 240 ha) of land would be affected in the most severe case (see Appendix A). Smaller areas of land would be affected in the other accidents analyzed. The affected area would require decontamination, and during this cleanup, temporary access controls would have to be established. The impact on issues such as socioeconomics, treaty rights, tribal resources, ecology, and land use would be relatively small and would be limited in time. The remediation actions would be simpler in rural areas than in urban areas, and provided that prudent controls and remediation operations were promptly implemented, the affected land and facilities could be recovered in either case. The accident analyses, provided in Appendices A and B and summarized in these sections, indicate that the human health effects would be small and the effects on wildlife and other biota would also be small, due partly to the limited area affected.

The slightly increased number of latent cancer fatalities associated with any alternative is based on the calculated increase in radiation dose that would be received by the general public as a result of using that alternative. The average annual dose from natural background radiation to a member of the population in the United States is approximately 0.3 rem (300 mrem) (National Council on Radiation Protection and Measurements [NCRP] 1987a). The average annual collective dose to all of the population in the United States from natural background radiation is approximately 79 million person-rem. When people are exposed to additional radiation, the number of additional radiation-induced cancers and other health effects needs to be considered. An estimate for radiation-induced latent cancer fatalities can be briefly summarized as follows:

- In a typical group of 10,000 persons who do not work with radioactive material, a total of about 2,000 (20%) will die of cancer from all causes (for example, cigarette smoking, improper diet, and chemical carcinogens).

- If each of the 10,000 persons received an additional 1 rem of radiation dose (10,000 person-rem) in their lifetime, then an estimated 5 additional latent cancer fatalities (0.05%) might occur.

- Therefore, the likelihood of a person developing a latent fatal cancer during his or her lifetime could be increased nominally from 20.00% to 20.05% by 1 additional rem of radiation dose.

The "factor" to convert dose to latent cancer fatalities for such a person, considering all possible organs, can be expressed as 0.0005 latent cancer fatality per rem of dose. This is mathematically equivalent to 5 latent cancer fatalities from 10,000 person-rem of collective dose to a large group of persons. (The factor is expressed in exponential notation as 5×10^{-4} latent cancer fatality per rem of dose.) See Section A.2.3 in Appendix A for further details on the calculations of cancer fatalities and risks.

The risks associated with any of the alternatives are low compared to many of the risks encountered in daily life. The risks of normal operations may be placed in perspective by considering other commonly encountered risks. For example, the average U.S. resident is exposed to approximately 0.5 mrem each year from the radioactivity released from combustion of fossil fuels (NCRP 1987b), which produces a lifetime risk of an average individual dying from a latent cancer of about 1 chance in 55,000. As an additional comparison, the naturally occurring radioactive materials in fertilizer used to produce food crops contribute about 1 to 2 mrem per year to an average U.S. resident's exposure to radiation (NCRP 1987b). This results in a calculated risk of death from a latent cancer between 1 chance in 12,500 and 1 chance in 25,000 over a lifetime. Risks associated with other activities encountered in daily life are included in Table 3.4.

TABLE 3.4 Risk Comparisons[a]

Cause of Death	Individual Lifetime Risk of Dying
Cancer: All causes	1 Chance in 5
Cancer: Exposure to Fossil Fuel Emissions	1 Chance in 55,000
Cancer: Naturally Occurring Radiation	1 Chance in 93
Cancer: INEL/ECF Operations	1 Chance in 30,000,000,000
Cancer: Incident-Free Transportation	1 Chance in 9,300,000
Automobile Accident	1 Chance in 87
Naval Spent Nuclear Fuel Transportation Accident	1 Chance in 39,000,000,000
Fire	1 Chance in 500
Poisoning	1 Chance in 1,000
ICPP Water Pool Draining	1 Chance in 600,000,000

[a]Notation: ECF = Expended Core Facility; ICPP = Idaho Chemical Processing Plant

A frame of reference for the risks from accidents associated with spent nuclear fuel management alternatives can be developed by comparing them to the risks of death from other accidental causes. For example, the lifetime risk of death in a motor vehicle accident is about 1 chance in 80 (National Safety Council 1993). Similarly, the lifetime risk of death for the average U.S. resident from fires is approximately 1 chance in 500 and the lifetime risk of death from accidental poisoning is about 1 chance in 1,000. The chance of being killed by lightning is approximately one chance in 39,000. Compared to these risks, the risk of a single latent cancer fatality of one in 400,000 years for an accident with a multi-purpose canister given earlier in this section is small.

The average member of the general public will not receive as much as one-thousandth of a rem of radiation dose due to the normal operations associated with any of the alternatives being considered in this EIS. The tables of radiation doses in Appendices A and B show that the principal sources of the differences in the doses associated with the radiation and radioactive materials released from normal operations and from hypothetical accidents for these alternatives are the different numbers of people who live in the vicinity of the facility being evaluated and where they live relative to the facility itself. When the emissions from the sources are essentially the same, the resulting impacts depend directly on the size of the surrounding population, on the way the population is distributed around the site in terms of the distances and direction from the particular source, and on the characteristics of the local meteorology.

Environmental justice assessments have been performed for manufacturing operations, handling and storage at INEL facilities, and for transportation of naval spent nuclear fuel. The environmental consequences and impacts on health and safety for the actions described in this EIS would be small for all population groups and therefore, it would be expected that there would be no disproportionately high or adverse impacts to any minority or low-income population.

Implementation of any of the alternatives for the management of naval spent nuclear fuel and special case waste would generate some waste with the potential for releases to air and water. To control both the volume and toxicity of waste generated and to reduce impacts on the environment, pollution prevention practices would be implemented.

The Navy and the DOE are responding to Executive Order 12856, Federal Compliance with Right-to-Know Laws and Pollution Prevention Requirements, and associated navy instructions or DOE orders and guidelines by reducing the use of toxic chemicals; improving emergency planning, response, and accident notification; and encouraging the development and use of pollution prevention technologies. Pollution prevention programs have been implemented at each Navy and DOE site. Program components include waste minimization, source reduction and recycling, and procurement practices that preferentially procure products made from recycled materials. Portions of the pollution prevention program have been implemented at the existing DOE and naval sites for nearly 10 years. Waste minimization programs have decreased the amount of all waste types generated by making material substitutions.

Implementation of the pollution prevention plans would continue to minimize the amount of waste generated during the manufacturing of containers and the handling, storage and transportation of naval spent nuclear fuel and special case waste.

3.8.1 Manufacturing Impacts

The environmental impacts of manufacturing the required containers and overpacks would be small for any of the alternatives. A summary of potential manufacturing impacts is provided in Table 3.5. Impacts due to material use and recycling and management of end-of-life equipment are discussed in Section 4.5.2 of Chapter 4.

TABLE 3.5 Summary Comparison of Manufacturing Potential Impacts[a]

Parameter	Potential Impacts from the Alternatives [b]					
	MPC	NAA	CTR	TSC	DPC	SmMPC
Air emissions (total, tons)						
Volatile organic compounds	2.7	2.3	2.0	1.9	2.6	4.4
Nitrogen oxides	3.5	3.1	2.7	2.5	3.4	5.7
Industrial accident fatalities (total numbers)	0.022	0.019	0.017	0.016	0.022	0.036
Material use (total as % U.S. annual production)						
Steel	0.018	0.020	0.016	0.018	0.019	0.023
Chromium[c]	0.22	0.24	0.12	0.29	0.18	0.25
Nickel	0.066	0.072	0.036	0.086	0.052	0.073
Lead	0.021	0.000	0.000	1.3	0.15	0.029
Depleted uranium	6.4	0.000	0.000	0.000	0.000	7.5
Waste generated (Annual average, tons)						
Liquid	0.16	0.14	0.12	0.12	0.16	0.27
Solid	0.022	0.019	0.017	0.016	0.022	0.036
Socioeconomics (% change over local baseline)						
Annual average output	0.04	0.04	0.04	0.04	0.04	0.05
Annual average income	0.04	0.04	0.04	0.04	0.04	0.05
Annual average employment	0.04	0.04	0.04	0.04	0.03	0.05

[a] Notation: MPC = Multi-Purpose Canister; NAA = No-Action; CTR = Current Technology/Rail; TSC = Transportable Storage Cask; DPC = Dual-Purpose Canister; SmMPC = Small Multi-Purpose Canister.

[b] Includes the impacts from special case waste.

[c] Compared with the Federal Strategic and Critical Inventory.

People are normally concerned about air quality in the vicinity of manufacturing locations. The small values for the estimated air emissions listed in Table 3.5 are typical of the small environmental impacts that would be involved in the manufacturing of these containers. For example, volatile organic compounds and nitrogen oxides are released from these manufacturing processes into the local atmosphere. Also, volatile organic compounds and nitrogen oxides are released to the atmosphere by other manufacturers in the same locality. The maximum contribution of the container manufacturer in a peak year to the total contributions of all manufacturers in an average year is estimated to be only 0.003% for volatile organic compounds and 0.0003% for nitrogen oxides. This indicates that the air emissions from container manufacturing would be a small part of the prevailing totals. The manufacturing impacts are considered to be small for any alternative. The impacts on air quality, health and safety, material use, waste generation, and socioeconomics from manufacturing the various components would be similar and small for all alternatives. No land-use impacts would be expected because manufacturing would likely occur at existing facilities. Disproportionately high and adverse impacts on minorities or low-income groups are not expected to occur.

The largest impacts on air quality, health and safety, and waste generation would occur under the Small Multi-Purpose Canister Alternative, due primarily to the larger number of canisters and disposal overpacks that would be required. The largest material use impacts would occur if the transportable storage cask system were chosen. The nature of the transportable storage casks as an integral storage and transportation unit means that more materials are required for this system. Total material use of the five major constituent materials over 40 years would be small compared with the current annual U.S. production rates (or, in the case of chromium, the strategic inventory). A higher percentage of depleted uranium would be required for the Multi-Purpose Canister and Small Multi-Purpose Canister Alternatives, but few alternative uses exist for this material. The largest socioeconomic impacts would occur under the Small Multi-Purpose Canister Alternative. The average socioeconomic impact is less than 0.05% for the majority of alternatives when compared to the local economic baseline in the representative manufacturing location. These socioeconomic impacts would be beneficial to the areas affected. Further details on manufacturing impacts are provided in Chapter 4. Waste generation resulting from the management of end-of-life equipment would be minimized by reuse or recycling. (Section 4.5.2)

The cost of the new containers is expressed as the output of the manufacturing operations in terms of the value of the goods and services produced at a representative location during the manufacturing period. The average annual output ranges from a minimum of $10 million (dual-purpose canister) to a maximum of $15 million (small multi-purpose canister).

The jobs associated with the fabrication of the new containers are expressed as the number of person-years of employment that would be required during the manufacturing period. The average annual employment ranges from a minimum of 130 person-years (dual-purpose canister) to a maximum of 180 person-years (small multi-purpose container). These values of output and employment are about 0.04% of the corresponding local totals. Additional details on the manufacturing impacts are provided in Sections 4.7 of Chapter 4 and C.1 of Appendix C.

3.8.2 Loading and Storage Impacts for INEL Facilities

During normal operations associated with loading and storage of naval spent nuclear fuel at INEL, there are small impacts on the public and the workers due to direct radiation and due to the release of radioactive materials to the environment. These impacts are presented in Table 3.6 as the total risk of latent cancer fatalities in the maximally exposed individuals (MEI) in the occupational group (facility workers) and in the general public due to exposure to radiation or radioactive materials released. It is important to emphasize that these latent cancer fatalities are calculated results rather than actual expected fatalities. This is because the expected number of such fatalities during normal operations is so small as to be unmeasurable and indistinguishable relative to the larger number of such deaths expected from naturally occurring conditions and other man-made effects not related to naval spent nuclear fuel operations. The differences are small among the alternatives, except that the risks to the maximally exposed individual in the general public from the No-Action Alternative and the Current Technology/Rail Alternative are higher than risks from the other four alternatives by a factor of about six. This is due to the assumed release of carbon-14 from opening of containers in dry storage to place fuel assemblies into the M-140 transportation cask. The risks to the facility worker are the same for all alternatives and do not provide a basis for distinguishing among the alternatives. Further information on the impacts of loading and storage at INEL are provided in Chapter 5.

The socioeconomic impacts associated with operations at INEL involving naval spent nuclear fuel would also be minor with any of the alternatives chosen. About 10 to 50 additional workers might be required to handle the loading of naval spent nuclear fuel into containers under any alternative. This work force would be expected to be available from within the existing INEL work force or from the local work force, so the total effect on local employment would be small. Further information on socioeconomics is provided in Appendix C.

TABLE 3.6 Total Risk of Latent Cancer Fatalities in the Maximally Exposed Individuals in the Occupational Group and in the General Population for Normal Facility Operations at INEL[a]

	Risk of Latent Cancer Fatalities[b]	
Alternative	Facility Worker	MEI, General Public
Multi-Purpose Canister	1.8×10^{-4}	4.9×10^{-9}
No-Action	1.8×10^{-4}	2.8×10^{-8}
Current Technology/Rail	1.8×10^{-4}	2.8×10^{-8}
Transportable Storage Cask	1.8×10^{-4}	4.9×10^{-9}
Dual-Purpose Canister	1.8×10^{-4}	4.9×10^{-9}
Small Multi-Purpose Canister	1.8×10^{-4}	4.9×10^{-9}

[a] Values are derived from Tables A.10 and A.11. This table assumes 40 years of exposure to loading and dry storage operations at Naval Reactors Facility (NRF), and 28 years of exposure to loading operations and 40 years of dry storage operations at Idaho Chemical Processing Plant (ICPP), for naval spent nuclear fuel and special case waste. See Section A.2.3 for perspective on calculations of cancer fatalities and risk. Notation: MEI = Maximally exposed individual.

[b] Maximum values among facility workers and the maximally exposed individuals in the general public due to facility operations at NRF and ICPP.

3.8.3 Impacts of Unloading at a Repository or Centralized Interim Storage Facility

During normal operations at the repository site or at the centralized interim storage site, there would be small impacts on the public and on the workers due to direct radiation and due to the release of radioactive materials to the environment. These impacts have been calculated and are presented in Table 3.7 as the total risk of latent cancer in the maximally exposed individuals in the occupational group and in the general public. The results indicate that the impacts would be small for both the facility worker and the maximally exposed individual in the general public. The risk to the public individual is smaller than the risk to the facility worker. Both of the Multi-Purpose Canister Alternatives are calculated to present no risk of latent cancer fatalities to either the facility worker or the maximally exposed individual in the general public. This is due to the canisters being sealed by welding and would not contribute any airborne releases. The other four alternatives are assessed as presenting equal risks and do not provide any basis for distinguishing among those alternatives. Further information on the environmental consequences of operations at a repository or centralized interim storage site are provided in Chapter 6.

TABLE 3.7 Total Risk of Latent Cancer Fatalities in the Maximally Exposed Individuals in the Occupational Group and in the General Population for Normal Facility Operations at a Repository or at a Centralized Interim Storage Site[a]

	Risk of Latent Cancer Fatalities[b]	
Alternative	Facility Worker	MEI, General Public
Multi-Purpose Canister	0[c]	0[c]
No-Action	5.4×10^{-7}	1.8×10^{-8}
Current Technology/Rail	5.4×10^{-7}	1.8×10^{-8}
Transportable Storage Cask	5.4×10^{-7}	1.8×10^{-8}
Dual-Purpose Canister	5.4×10^{-7}	1.8×10^{-8}
Small Multi-Purpose Canister	0[c]	0[c]

[a] Values are derived from Table A.12. This table assumes 25 years of exposure to unloading operations. See Section A.2.3 for perspective on calculations of cancer fatalities and risk. Notation: MEI = Maximally exposed individual.

[b] Maximum values among facility workers and the maximally exposed individuals in the general public due to unloading operations at a repository site or centralized interim storage site, including the risk from special case waste.

[c] Sealed multi-purpose canister would not contribute any airborne releases.

In contrast to the latent cancer fatalities estimated for the maximally exposed individuals in the occupational group and in the general population, shown in Tables 3.6 and 3.7, an estimate was made for the total latent cancer fatalities in the entire population of radiation workers associated with 40 years of loading and storage operations and 25 years of unloading operations. The collective worker doses ranged from 550 person-rem (Transportable Storage Cask Alternative) to 1500 person-rem (Small Multi-Purpose Canister Alternative). The corresponding latent cancer fatalities ranged from 0.22 to 0.59, or less than one latent cancer fatality in the entire group for the whole period of 40 years.

3.8.4 Transportation Impacts

During normal, incident-free transportation of naval spent nuclear fuel and special case waste, there would be impacts on the public and on the rail crew (occupational) due to direct radiation. These impacts have been calculated and the results are presented in Table 3.8 as the total risk of latent cancer fatalities in the maximally exposed individuals in the occupational group and in the general public. The results indicate that the impacts would be small in either category. The risk to the public maximally exposed individual is smaller than the risk to the occupational maximally exposed individual. Among the alternatives the risks associated with the No-Action Alternative and the Current Technology/Rail Alternative are noticeably lower than the others. This is attributed to using actual historical measured doses for the M-140 containers; the other alternatives were calculated conservatively. The Small Multi-Purpose Canister Alternative presents the largest risk because more shipments are required with the smaller canister. Further information on transportation impacts is provided in Chapter 7.

TABLE 3.8 Total Risk of Latent Cancer Fatalities in the Maximally Exposed Individuals in the Occupational Group and in the General Population for Incident-Free Transportation[a]

	Risk of Latent Cancer Fatalities[b]	
Alternative	MEI, Occupational	MEI, General Public
Multi-Purpose Canister	4.4×10^{-3}	6.7×10^{-4}
No-Action	7.2×10^{-4}	9.0×10^{-5}
Current Technology/Rail	5.7×10^{-4}	7.1×10^{-5}
Transportable Storage Cask	4.3×10^{-3}	6.4×10^{-4}
Dual-Purpose Canister	4.2×10^{-3}	6.6×10^{-4}
Small Multi-Purpose Canister	7.1×10^{-3}	1.1×10^{-3}

[a] Values are derived from Table B.10. This table assumes 25 years of exposure to transportation operations for naval spent nuclear fuel and special case waste. See Section A.2.3 for perspective on calculations of cancer fatalities and risk. Notation: MEI = Maximally exposed individual.
[b] Maximally exposed individuals, occupational and general public, due to transportation operations.

Nonradiological impacts due to incident-free transportation of naval spent nuclear fuel and special case waste have been calculated and are presented in Table 3.9. The incident-free fatalities that occur in the general public are attributed to the effects of such things as exhaust fumes from diesel-powered engines.

Nonradiological impacts due to the risk of traffic accidents are also presented in Table 3.9. These impacts are calculated from statistics that reflect the frequency of train traffic fatalities. The calculated numbers of fatalities due to traffic accidents are greater than the fatalities due to incident-free transportation. Among the alternatives, the values lie in a narrow range; the maximum is due to the Small Multi-Purpose Canister Alternative and is attributed to the larger number of shipments that this alternative requires. All of the alternative container systems would be suitable for heavy-haul transportation, as illustrated by prior use of the M-140 containers in heavy-haul transport. However, it is accurate to state that the M-140 based alternatives would be less suitable due to size, height, and weight.

TABLE 3.9 Nonradiological, Incident-Free Transportation Risk and Accident Risk for the Total Number of Shipments[a]

Alternative	Incident-Free Nonradiological Fatalities[b]	Accident Risk Traffic Fatalities[c]
Multi-Purpose Canister	5.2×10^{-4}	0.055
No-Action	6.9×10^{-4}	0.073
Current Technology/Rail	5.5×10^{-4}	0.058
Transportable Storage Cask	5.3×10^{-4}	0.056
Dual-Purpose Canister	5.0×10^{-4}	0.052
Small Multi-Purpose Canister	8.4×10^{-4}	0.089

[a] This table assumes 25 years of exposure to transportation operations for naval spent nuclear fuel and special case waste.
[b] Values from Table 7.4.
[c] Values from Table 7.5.

3.8.5 Summary of Cumulative Impacts

Manufacturing. The cumulative environmental impacts resulting from the manufacturing of container systems would be very small. The containers needed for naval spent nuclear fuel represent about 1 to 4 percent of the total number of containers needed for both naval and civilian spent nuclear fuel which would be shipped to a repository or centralized interim storage site. The total material use over the 40-year period for naval spent nuclear fuel and special case waste is less than 0.3 percent of the annual material use in the United States except for depleted uranium and lead. Use of depleted uranium and lead are also small percentages of the available materials in the United States.

Facilities. For facility operations at INEL involving handling and storage of naval spent nuclear fuel, the cumulative environmental impacts are small when compared to the impacts of operation of the entire INEL. The loading and storage operations for naval spent nuclear fuel would not result in discharges of radioactive liquids. None of the alternatives considered would cause the total air emissions to exceed any applicable air quality requirement or regulation in any radiological or non-radiological category. No additional land would have to be withdrawn from public use as a result of the handling and storage of naval spent nuclear fuel because the INEL is a federal reservation. There would be only minor cumulative impacts associated with the INEL facilities.

At a repository or a centralized interim storage site, the naval spent nuclear fuel and special case waste would be about 3 percent of the total number of containers of civilian spent nuclear fuel received at a facility over 25 years. Therefore, it is expected that the impacts of unloading naval spent nuclear fuel at a facility would have little effect on the environment and population surrounding the site.

Transportation. The total impact of the transportation of naval spent nuclear fuel and special case waste would be approximately 1 to 4 percent of the total impact of all spent nuclear fuel shipments to a geologic repository or a centralized interim storage site. The transportation risks, both radiological and nonradiological, are extremely small when compared to the cumulative impacts of the shipment of all nuclear materials in the United States (DOE 1995).

3.9 Preferred Alternative for Naval Spent Nuclear Fuel

Although the Navy did not have a single preferred alternative at the time the Draft EIS was issued, the Draft EIS noted that, ideally, the selected container system will economically allow naval spent nuclear fuel to be loaded and stored dry at INEL in the same container which will be used to ship the spent nuclear fuel outside the State of Idaho. The Multi-Purpose Canister, Dual-Purpose Canister, Transportable Storage Cask, and Small Multi-Purpose Canister Alternatives could effectively meet current and future needs, whereas the Current Technology/Rail and No-Action Alternatives would require movement of individual spent nuclear fuel assemblies from one container to another for transportation, storage, and disposal.

The identification of a preferred alternative in this Final EIS takes into consideration the following factors: (1) public comments; (2) protection of human health and the environment; (3) cost; (4) technical feasibility; (5) operational efficiency; (6) regulatory impacts; and (7) storage or disposal criteria which may be established for a repository or centralized interim storage site outside the State of Idaho. The direction of the commercial nuclear industry, standardization and technical uncertainties and risks were considered with the factors above. The selection of an alternative in the Record of Decision will consider the same factors. Based on an evaluation of these factors, summarized below, the Navy's preferred alternative for a container system for the management of naval spent nuclear fuel is a dual-purpose canister system. The overriding benefit of a canister system is that it minimizes fuel handling operations. This benefit represents efficiencies in container manufacturing, fuel reloading operations, and radiation exposure. In addition, the use of dual-purpose canisters would result in the fewest number of shipments. As with all the alternative container systems evaluated in this EIS, the Navy's preferred alternative will allow the safe storage and shipment of naval spent nuclear fuel for ultimate disposition.

This EIS also evaluates options for a dry storage facility for naval spent nuclear fuel, including existing facilities at INEL and currently undeveloped locations potentially not above the Snake River Aquifer. The technical feasibility of building a dry storage facility within INEL at a point removed from above the Snake River Plain Aquifer was considered in this EIS pursuant to the October 17, 1995 Court Order in Civil Case No. 91-00540-5-EJL (U.S. District Court, 1995) and the agreement with the State of Idaho, the U.S. Navy and the U.S. Department of Energy. Two possible locations have been identified, one located along the west boundary of INEL and the other in the northwest corner of the INEL reservation. However, neither of these locations is hydrologically removed from above the Snake River Plain and, because of their close proximity to seismic faults, they are technically undesirable locations. In addition, a facility located at either of these sites would be closer to the site boundaries and the local population than existing INEL facilities (approximately 1 mile from the INEL boundary at its closest point). If such a location would be selected, impacts would result from construction of a road and possibly a rail spur to the location as well as construction of facilities at the location and possibly rail access. A review of these areas indicates that the development of a dry storage facility at either of these remote locations might have a greater impact on Native American cultural resources, ecological resources, and land use than providing for dry storage at a site adjacent to the Expended Core Facility at the Naval Reactors Facility or at a site at the Idaho Chemical Processing Plant. These locations are assessed in Appendix F of this EIS.

The Navy's preferred alternative for a dry storage location for naval spent nuclear fuel is to utilize either a site adjacent to the Expended Core Facility at the Naval Reactors Facility or a site at the Idaho Chemical Processing Plant at INEL. These locations offer several important advantages, including already existing fuel handling facilities and trained personnel. In addition, use of these INEL facilities would protect previously undisturbed areas; development of these undisturbed sites would incur increased adverse environmental impacts while offering no environmental advantage.

3.9.1 Preferred Alternative Evaluation

In order to identify the Dual-Purpose Canister System Alternative as the preferred alternative, the Navy evaluated each of the six alternatives using several criteria. The Draft EIS identified the following factors to be considered in selecting a preferred alternative:

- Public comment
- Protection of human health and the environment
- Cost
- Technical feasibility
- Operational efficiency
- Regulatory impacts
- Storage or disposal criteria outside of the State of Idaho which may be established.

Other considerations implicit in the factors above include the direction of the commercial nuclear industry, standardization and technical uncertainties and risks.

All of the considerations cited above were weighed, as criteria, for each alternative system. A discussion of each criterion and the evaluation of the alternatives against each criterion is provided below.

Public Comments. Thirteen commenters out of approximately fifty stated a preference for one alternative or another, and there were no objections to any specific alternative. Therefore, there was no obvious preference based on public comments.

Protection of Human Health and Environment. The environmental and public health impacts from the manufacture of any of the container systems, the operations of handling, storage, transportation, and unloading at a repository, and the construction of any facilities would be small and would differ little among the alternatives.

The estimated increase in radiological risk for the No-Action and the Current Technology/Rail Alternatives is smaller than for the other alternatives because actual measured radiation levels on the M-140 were used for the incident-free transportation risk calculation. These actual measured levels are significantly lower than the levels allowed by regulation. For the other four alternatives, the maximum radiation levels allowed by regulation were used in the incident-free transportation risk calculations because no data exist showing radiation levels for naval spent fuel in such containers. For the four alternatives that used maximum allowed radiation levels, the risk increase was small and essentially the same. The increase in non-radiological risk for any of the alternatives is approximately equal, with any variations being due to differences in the number of shipments.

Because the impacts to human health and the environment for all six alternatives would be very small, all alternatives are considered to be comparable and indistinguishable under this criterion.

Cost. To compare the overall costs of each alternative, the following elements of cost were considered:

- Container procurement costs
- Handling costs
- Storage costs
- Transportation costs
- Container disposal costs
- Facility construction or modification costs.

Table 3.10 provides a summary of costs which is based mostly on procurement costs for equipment. The handling, storage, transportation and container disposal costs are factored into the overall cost ranking.

TABLE 3.10 Cost Comparisons of Alternatives

Alternative	Container Procurement Cost	No. of Times Fuel Assemblies Handled	No. of Shipments	Storage No. of Containers	Overall Cost Ranking
Multi-Purpose Canister	$280 million	1	300	150	1
No-Action	$450 million	3	425	225	3
Current Technology/Rail	$405 million	3	325	150	2
Transportable Storage Cask	$725 million	2	325	150	2
Dual-Purpose Canister	$460 million	2	300	150	2
Sm Multi-Purpose Canister	$830 million	1	500	225	2
Dual-Purpose Canister[1]	$280 million	1	300	150	1[1]

[1] Assumes that the canister is acceptable for disposal based on its similarities to the multi-purpose canister.

Notation:
1 = highest rating = lowest comparative cost
2 = medium rating = medium comparative cost
3 = lowest rating = highest comparative cost

The basis and assumptions used to estimate and compare overall costs are summarized below:

The estimated number of containers required for each alternative was used with the estimated cost per container to compare alternatives. The numbers of containers required were estimated assuming initiation of shipments to a repository in 2010 and continued disposal through the year 2035 and assuming that all of the naval spent nuclear fuel would be placed into the same type of disposal container.

The basic hardware cost includes the manufacturing of the various hardware components such as canisters; storage, transportation and disposal overpacks; casks for storage and/or transportation; and disposal containers.

The cost to develop and license a container system, costs to construct or modify facilities, and storage site construction costs were considered in the evaluation, but are considered to be small compared to the total cost and similar among alternatives.

For comparison purposes, it was assumed that for all alternatives, except the transportable storage cask, all post-examination naval spent nuclear fuel pending final disposal would be placed in a storage canister in a concrete overpack. Use of a metal cask storage overpack would be expected to increase cost proportionately for all alternatives.

The cost of actual spent fuel disposal was estimated to be approximately the same for all alternatives.

The comparison of costs other than procurement is based on the number of containers required. This comparison assumes that a shipment in any of the alternatives costs about the same, and that disposal of the storage or transportation overpacks for any of the alternatives costs about the same.

Based on the comparison of potential facility modifications required, it appears that modifications required for implementing a canister-based technology would be slightly higher than for a cask-based technology. However, the costs would be small when compared to the total facility costs and other container system procurement costs. Therefore, the facility modification costs for all of container system alternatives were estimated to be about the same.

The overall cost comparisons are based mostly on relative procurement and handling costs.

While the design criteria for the disposal packages have not yet been completely specified, it seems reasonable at this time to assume that the Dual-Purpose Canister Alternative may also meet the disposal acceptance criteria. In this event the dual-purpose canister and multi-purpose canister would entail similar costs for the ultimate disposal in a geologic repository.

To summarize, the principal differences in cost are due to the container procurement costs and handling expenses associated with spent fuel containerization.

Technical Feasibility. The technical feasibility of each container system alternative has been evaluated for two representative naval fuel configurations: a submarine and a surface ship. The difference in these configurations is simply dimensional with the surface ship spent fuel being larger. Structural, criticality, shielding, and thermal performance of the representative fuels in each of the six container system alternatives have been considered. The conclusion is that all of the container alternatives technically support the storage, shipment, and disposal of naval spent nuclear fuel.

All of the alternatives would be equally satisfactory under this criterion.

Operational Efficiency. The processes which must be performed for any of the alternatives include: loading fuel into storage containers, unloading fuel from storage containers for shipment, off-site transport, and loading or reloading fuel at a geologic repository surface facility for ultimate disposal. Each of these general operations may be performed once, multiple-times, or not at all, depending on the system implemented.

Each of the alternatives can be categorized as either a cask or a canister system based on whether the naval spent nuclear fuel would be transferred from storage for shipment as individual fuel assemblies or as a unit inside a sealed package (canister). Several steps are required to unload the individual fuel assemblies from a canister; however, canister unloading at INEL is not anticipated. It is assumed that if the canister is unacceptable for placement in the repository, it will be unloaded at the repository and the fuel recontainerized there for ultimate disposal. The unloading of individual fuel assemblies is not assumed for the Multi-Purpose Canister Alternatives since it is assumed those canisters meet repository waste acceptance criteria.

It is concluded from the process evaluation that multi-purpose canister systems would be more efficient systems when considering the handling of fuel. The most inefficient systems from this standpoint are the No-Action and the Current Technology/Rail Alternatives because individual fuel assemblies must be handled for each packaging operation.

Individual fuel assemblies would not have to be unloaded from the canisters once they had been loaded for the multi-purpose canister alternatives. The individual fuel assemblies would be handled only one time: during the initial loading of the canister.

For the dual-purpose canister system, the individual fuel assemblies would be loaded into a canister prior to storage. The canister would not need to be reopened prior to packaging the canister for transportation. It is possible that at a geologic repository the individual fuel assemblies may need to be handled in the process of packing disposal containers. If the canisters meet the disposal criteria, when they are established, the dual-purpose canister system in effect becomes the multi-purpose canister system in that the individual fuel assemblies will be handled only once.

For the transportable storage cask the individual fuel assemblies will be placed into the cask prior to storage and transportation of the naval spent nuclear fuel. At a geologic repository the individual fuel assemblies would be handled a second time for packaging into the disposal containers.

Although handling fuel is routinely accomplished safely without impact on human health or the environment, doing it multiple times is inefficient, incurs additional occupational radiation exposure, and some risk.

Based on both the process evaluation and the comparison of operational complexities associated with each alternative, it is concluded that the multi-purpose canister systems are ranked highest in regard to operational efficiency. The dual-purpose canister and the transportable storage cask alternatives require that the fuel assemblies are handled two times. However, if a dual-purpose canister is found to be acceptable for disposal, it would be considered equivalent to the multi-purpose canister system. The two current technology alternatives clearly require the most handling of individual fuel assemblies.

Regulatory and Disposal Criteria Impacts. This criterion includes the impact that changes to regulations for spent nuclear fuel may have on any of the alternatives. The regulations on storage, transportation, and repository disposal and the repository requirements on the material to be disposed are subject to revisions.

At this time, the only anticipated changes that may affect the preferred alternative are in the area of repository disposal regulations. The Nuclear Regulatory Commission has stated that the repository disposal regulations of 10 CFR 60 will be revised. The Environmental Protection Agency is expected to issue revised draft standards for a geologic repository by the end of 1996. The Nuclear Regulatory Commission will issue changes to 10 CFR 60 to establish design criteria within one year of the issue of the Environmental Protection Agency standards.

Based on the uncertainties and far term nature of the disposal regulations, there are no discernible advantages or disadvantages associated with any of the alternatives based on potential impact of disposal regulations. No impacting changes in the storage and transportation regulations are anticipated and all of the alternatives would meet the current regulations.

All of the alternatives are considered to be equal under this criterion.

Direction of Industry and Standardization. In implementing a container system for the management of naval spent nuclear fuel, there is an advantage in utilizing a system compatible with the systems in use or planned for use by operators of reactors which commercially generate electricity. The reason for this criterion is that all spent nuclear fuel, commercial and naval, is likely to be destined for the same geologic repository or centralized interim storage site with naval spent nuclear fuel containers representing only about 1 to 4 percent of the total number of containers that would be shipped to such a facility. Therefore, to the extent that the most widely used systems for commercial spent nuclear fuel drive any repository design or acceptance criteria, it is considered prudent to utilize a system which is similar to the systems being used or planned for use by commercial electrical utilities. In addition, there are other advantages to using the same system or one similar to that the commercial utilities have recently licensed through the Nuclear Regulatory Commission. The advantages are that extensive technical reviews have already been conducted, peer and public review have been accomplished, and some proven applications may be in operation.

The majority of the new spent nuclear fuel storage systems being designed or in review by the Nuclear Regulatory Commission are dual-purpose systems with different overpacks for storage and transport.

The 125-ton multi-purpose canister, the 75-ton multi-purpose canister, the transportable storage cask and the dual-purpose canister system all fulfill this criterion. The No-Action and the Current Technology/Rail Alternatives do not meet this criterion.

Technical Uncertainties and Risks. There are no substantial technical uncertainties associated with the loading of naval nuclear spent fuel into storage containers, the storage of the containers at INEL, or the transportation off-site to a geologic repository. All of the alternatives assume the use of containers which will meet the storage requirements of 10 CFR 72 and the transportation requirements of 10 CFR 71. Several licensed systems are currently in use and other new systems are in the review cycle for Nuclear Regulatory Commission approval for use.

The waste acceptance criteria for a geologic repository have not yet been established. As a result there is some uncertainty in implementing a multi-purpose canister system. Since the current design uses welded closures, if the canister would not be compatible with the geologic repository criteria, the fuel canisters may need to be reopened, the individual fuel assemblies may have to be rehandled, and placed into acceptable disposal containers. In this event the multi-purpose canister system would be similar to the dual-purpose canister system. For the dual-purpose canister system or the cask-based systems rehandling of the individual fuel assemblies has been considered in the evaluation of the alternatives.

3.9.2 Preferred Alternative Summary

After consideration of the factors discussed above, the preferred alternative for a container system for the management of naval spent nuclear fuel is the Dual-Purpose Canister Alternative. A system allowing the naval spent fuel assemblies to be loaded into a canister with a welded closure which can be placed into separate shielded storage overpacks and transportation overpacks would allow the Navy to take advantage of savings in costs, occupational exposure, handling complexity, and environmental impacts associated with handling and waste generation in comparison to the No-Action and Current Technology/Rail Alternatives which require additional handling of individual fuel assemblies.

While a multi-purpose canister system has the potential to produce even greater savings in these areas, the disposal container design and waste acceptance requirements for a geologic repository have not yet been established. This means that multi-purpose canister systems do not provide any definite functional advantages over the dual-purpose canister system at this time.